13: Beaglehole & Beaglehole E-5 (1938-1939) 1941
OU9 Tonga OU9
Vavau
Pangai

plants. The above staples would be planted as required in such a way as to keep the amounts and proportions fairly constant.

Such is the fertility of the Pangai soil that only a small part of a man's *api* is used for garden-purposes. Thus Biukala controls three *api* which total about fifty acres. He allows a relative to garden two acres of one *api*. The remainder of this *api* is given over to bush and coconuts. The second *api* is not cultivated but is used for coconut-production. On the third *api* Biukala gardens about three acres for his own household needs, taking coconuts from the remainder. From these three *api* Biukala thus supports his own household and that of a relative as well as securing, under optimum conditions, about twenty-five tons of copra each year. Most villagers with their normally small *api* can easily produce enough food for their households (if they are reasonably industrious according to Tongan standards) and can also expect to obtain up to five tons of copra each year.

Such also is the fertility of the soil that there appear to be few beliefs, if any, of a magical nature associated with garden cultivation. The villager knows full well that most of what he plants will grow. Insect pests, high winds and hurricanes, excessive rain or excessive dryness will affect his harvest from time to time. But it is convenient today to look upon these natural events as God-sent against which the skill and hopes of man avail nothing. Similarly the influence of government agricultural experts and of agricultural teachers in the government and mission-colleges tends to inculcate a scientific fatalism where religious fatalism leaves off. Neither agricultural art nor religious excuse, taken singly or together, leaves much ground for specifically magical belief or practice. Garden magic therefore, is conspicuously absent in the emotional and intellectual make-up of the average Pangai cultivator.

LIVESTOCK

Most households in the village own at least several pigs. These are necessary not so much for ordinary food-consumption but in order to fulfil feast obligations whenever these fall due at times of birth, marriage, death, visits of

22: West M-3 (1846-1855) 1865 OU9 Tonga OU9

CHAPTER VI.

RICHNESS of the soil—Native method of manuring—Banana Plantations—Bread-fruit and native bread—Varieties of edible fruits—The Coffee-plant—The yam, and method of its cultivation—Other edible roots—Kitchen vegetables—The Cocoa-nut tree, and oil manufacture—English manufactory at Foa—Cotton-growing in Tonga—Native ideas of labour—Timber trees.

THE soil of the low islands is composed of a rich 134
black mould, with more or less of admixture with
sand, according to the distance from the sea. This
black mould, formed chiefly from decayed vegeta-
tion, ranges from three to six feet deep. In the
higher lands the soil varies from that of the black
mould to a tolerably stiff yellow and reddish clay.
Speaking generally, the arable soil rests either [133]
immediately upon the surface of a conglomerate
coral rock, or else upon an intervening stratum of
light clay and sand. Such is the natural fertility 242
of the land, and such also the rapidity with which [134]
vegetation grows and decays, under these tropical
skies, that the natives never think of employing
artificial means to improve the soil. They have,
nevertheless, a good knowledge of some of the best
principles of agricultural science. They understand 242
the necessity for a rotation of crops, and regularly 244
practise this in regard to yam plantations. At 245
suitable intervals they plant the yam grounds
plentifully with banana trees; by which plan
several great advantages are secured for succeeding
crops. The herbaceous nature of the trunk of this 245
tree, and the extent of surface presented by the 242
immense leaves, tend to accumulate and deposit a

[p. 129]

22: West M-3 (1846-1855) 1865 OU9 Tonga OU9

vast amount of moisture in the soil during the period of growth. In addition to which, no sooner has the fruit ripened, than the parent tree is cut down, and its juicy trunk and roots are left to rot upon the surface. The process of decay is rapid; and meantime the young sucker-plants, which spring up from every parent stem, reach maturity in swift succession, to be cut down in a similar manner. These banana plantations are allowed to remain during one or two seasons, after which the ground is replanted with other products, or with the yam. As a rule the yam is not replanted, in the same ground, until the lapse of two or even three years. This system of resting the land, and permitting the bananas to rot, unquestionably answers all the purposes of ordinary manuring; but it necessarily involves the occupation of a much larger quantity of land, than would be required, were the principles of European agriculture adopted.

Perhaps there is no sight more distinctively tropical than that of an extensive banana plantation. In these islands all the varieties of the tree flourish in highest perfection. The plantain, (*Musa sapientum*,) so greatly used and esteemed in the West Indies, is not much thought of by the Tonguese; but all the other sorts, included in the *Musa paradisiaca*, or banana family, are extensively cultivated. The fruit hangs in single bunches upon a strong stem issuing from among the leaves. Each bunch will weigh from thirty to even eighty pounds. The fruit is of various colours, and of great diversity of form, according to the description of tree planted. It is usually long and narrow, of a pale-yellow, or dark-red colour, with a yellow or

39: Gerstle & Raitt C,Q-4,5 (1952-1972) 1974 (019 Tonga (

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The Government Experimental Farm in Vaini, Tongatapu, conducts experiments with livestock, soil, fertilizer, weed killers and crop rotation to improve agricultural techniques and production in Tonga. Photo above shows 'Otenili Tu'ipulotu (at right), the Farm Manager, and Sala Fia in the piggery at the Government Experimental Farm.

Faama 'Ahi'ahi 'a e Pule'anga 'i Vaini. 'Oku fai ai e ngaahi sipinga ngoue mo e tauhi manu kehekehe ke tokoni ki he fakalaka 'a e ngaue ki he kelekele. Ko e ta eni 'o e Pule Faama ko 'Otenili Tu'ipulotu (to'omata'u) pea mo Sala Fia 'i he fale fanga puaka 'i Faama.

gardeners try to plant one and sometimes two *ma'ala* a year. Giant taro (*Alocasia macrorrhiza*) and/or plantains and bananas are usually planted with the yam (*Dioscorea alata*), in rows 12 to 18 feet apart. In the more densely populated areas taro (*Colocasia esculenta*) is often inter-planted in the same plot, but in central and eastern Tongatapu this practice appears less common. When the yam is harvested it is replaced with taro, sweet potato or cassava. Taro is harvested as needed and as the tubers are dug the stems may be replanted for a second crop. Cassava may also be replanted one or more times, up to five successive crops being taken before the land is rested. The cropping sequence may sometimes end with plantains and bananas rather than tubers, with the former crops being inter-planted with the last crops of taro or cassava and being left on the land when these are harvested. Apart from yams, sweet potatoes may also begin a cycle of cropping. They are usually the first crop on sandy *tou'one* soils and are frequently grown on newly cleared land in the grassy areas of central Tongatapu. The next crop is then generally cassava, and bananas and plantains may be grown with the tubers.

Although definite but flexible patterns of crop succession and crop association (or inter-cropping) can be distinguished, the value of these is uncertain. Inter-cropping as practised in Tonga probably has some advantages. The growing of a variety of crops together provides a better cover for the soil, and consequently protection from sun and rain; the labour needs for weeding are also reduced. Different crops make different demands on the soil, and inter-cropping may therefore be a more efficient way of utilizing a garden area. On the other hand the patterns of crop succession appear to be related more to the requirements of the various crops than to any attempt to develop rotations which conserve soil fertility, and the basic crops which are rotated are all tubers, with the exception of bananas and plaintains. Yams are planted first because they require a loose soil well supplied with plant nutrients, conditions best found in land newly cleared from bush, while sweet potatoes, taro and cassava are less demanding and can be planted on land

[p. 59-A]

already cropped. Sweet potatoes do better on lighter or less fertile soils, which do not promote excessive leaf growth at the expense of tubers, while taro is generally grown on heavier soils. Cassava can be grown practically anywhere, and because it yields well even on poor soils is frequently last in the cropping sequence. 244

After a cropping period of from two to about five years the plot is bush fallowed. The cessation of gardening, however, is often gradual as taro, cassava, bananas or plantains may remain on the land and continue to be harvested for one or more years after cultivation of the plot has ceased, a practice which is not uncommon amongst shifting cultivators (Webster & Wilson, 1966). Taro may also be planted and left in the ground as a reserve against future needs. [245]

Some cash crops are grown as an integral part of the bush fallow system. Bananas, for example, are frequently planted as part of the cropping sequence and yield for only a few years before the land returns to bush. At present, however, with the very marked growth in banana exports over the last few years bananas increasingly are being grown in separate plantations, though often with some inter-cropping of food plants, and chemical fertilizers are being much more extensively used both to improve yields and to extend the life of the plantation. Watermelons are another, but minor, cash crop grown by the bush fallow system, as the first and sometimes the only crop planted on newly cleared land. 241 245 245 439 242 244

Coconuts, on the other hand, as a long-term tree crop, are not cultivated as part of the bush fallow system, but are unevenly scattered over part or all of each allotment. Most farmers prefer to keep part of their land free of coconuts, because they say that the shade cast by the palms lowers the yields of the crops grown under them, and in the past a common practice was to plant half of an eight and a quarter acre allotment in coconuts and leave the remainder fairly clear. Particularly in Ha'apai, however, those with small allotments (around three to five acres) have found it necessary to plant all their land to ensure a reasonable cash income. Consequently the Tongan farmer now rotates his gardens around 245 245 241

[p. 59-B]

43: Maude K-4,5 (1962) 1970
OU9 Tonga OU9

ing of the cropping period,[1] a change in the food crop pattern, and a complete areal merging of the bush fallow food cropping system and coconut growing. In some districts the agricultural system is now quite intensive by shifting cultivation standards, with a cropping period/fallow period ratio of about 1:1, and supports population densities of 500 to 600 persons per square mile (cf. Nye & Greenland, 1960, p. 128). However, despite the probable doubling in the intensity of cropping over the last three or four decades there has been no change in the most important element in the system, the technique of maintaining soil fertility. The vast majority of Tongan farmers still depend on a bush fallow, and while fertilizers are increasingly being used for some cash crops this is mostly in central and eastern Tongatapu, where the major commercial banana growers are concentrated, rather than in more densely populated and more intensively cultivated western Tongatapu or Ha'apai. Fertilizers are not used for subsistence crops, neither have other techniques such as planted fallows, composting, manuring or crop rotations been adopted. The agricultural system remains a fairly simple one, and the unsatisfactory features described in the previous section remain.

Two broad explanations for this lack of change in agricultural techniques can be offered. In the first place, it is possible that under Tongan conditions such improvements are not yet necessary. The soils, being derived from recent volcanic materials and not subject to intensive leaching in Ha'apai and Tongatapu, are of high inherent fertility. While the increased intensity of cropping appears to have resulted in a moderate decline in fertility status, it is possible that yields have been maintained by the adoption of new crops, particularly cassava. Furthermore, Nye and Greenland (1960, pp. 123, 129) point out that under a bush fallowing system it is possible to crop at varying levels of intensity and fertility without catastrophic consequences to the soil, and that up to a limit decreases in yields resulting from an increase in the intensity of cropp-

[1]According to Nye and Greenland (1960, p. 123) the general response of shifting cultivators to population increase is to change only the fallow period.

[p. 62-A]

43: Maude K-4,5 (1962) 1970
OU9 Tonga OU9

population growth over the last three decades, and consequently the rate of increase in the intensity of cropping, has probably been more rapid than the rate at which Tongan farmers are willing to change their established methods and particularly their habits of work. By contrast, the more elaborate techniques used by the New Guinea agriculturalists discussed by Brookfield (1962) and Clarke (1966) appear to have been developed over a lengthy period under conditions of slow population growth. Furthermore, in the past the Department of Agriculture has done very little experimental or extension work on the problem of maintaining soil fertility under food cropping, and most of the technical advice given has concerned cash crops. Consequently many Tongan farmers have little knowledge of the techniques that could be adopted, and unlike shifting cultivators in some other areas they have had no contact with peoples practising more advanced systems of subsistence agriculture.[2] They also have no tradition of livestock farming (except with pigs) which could be developed into an intensive farming system based on manuring, as is found in parts of Africa.

The relevance of Boserup's thesis to the process of agricultural change in Tonga may now be briefly reviewed. While none of the material presented above conflicts with her thesis that the intensification of traditional agricultural systems occurs only when forced by population pressure, for it is evident that differences in the intensity of cropping in Tonga are related to differences in population density rather than to differences in land quality, it does suggest some qualifications to her argument.

Firstly, not all of the adaptations made by Tongan farmers to population growth have involved increases in labour input, for one response has been to adopt a high yielding and easily cultivated crop such as cassava.[3] Secondly, a good deal of intensification seems possible without necessitating basic changes in the agricultural system. Short-term in-

[2]Compare the comments by Boserup (1965, pp.41, 64).

[3]On the other hand more labour is now required for clearing and weeding gardens and yields have probably been affected by the decline in soil fertility, but whether the net result has been a decline in output per man-hour is impossible to determine in the absence of data on labour inputs and production.

[p.63-B]

49: Rogers A-4,5 (no date) 1969 OU9 Tonga OU9

building small dwellings near the main dwelling for siblings of the opposite sex, parents, and married members of the same family.

The need to step up the rate of industrialisation is shown by the beginning of land shortages, the increase of adult "landless" men, the indirect evidence of under-employment throughout the Kingdom, and the movement of increasing numbers of rural dwellers to urban centres, especially to Nuku'alofa.

The most spectacular development in Tonga since 1956 has been the acquisition of a national shipping fleet. Before that date, two motorized sailing ketches were the principal means of inter-island transport; all fuel was imported from Fiji in 44-gallon drums. The progressive, far-sighted administration ordered the first vessel, *Aoniu* (514 tons), in 1956; it was delivered in 1958 and by 1960 it had made a gross earning of £T68,120 with net profits of £T13,970 after providing for depreciation and other running expenses. The Tongan fleet now comprises seven vessels, with the largest, *Niuvakai* (1,800 tons), plying between Sydney Australia, Japan, Fiji, and Tonga. Although great savings are now made each year on freights to and from the Kingdom, the shipping line has, however, done little to relieve the need for more jobs in Tonga. Raw materials could be transported to the Kingdom by these ships to provide employment in selected (possibly labour intensive) industries. If European and Australasian governments do not take the initiative by offering experts for this purpose it is likely that trade and aid may be forthcoming from Asia, especially from Japan.

Tonga has also shown how a state-owned industry can provide a large degree of independence for a small nation. The Tonga Copra Board and allied government agencies started with improving the quality of export copra, and now, with the aid of British finance, have launched a highly successful Coconut Replanting Scheme throughout the land. Government industries have already been discussed. Philatelic and numismatic sales are still being fully exploited by the Minister of Finance.

Nevertheless, economic growth, although spectacular for a country using mainly its own limited resources, is not fast enough to cater for the demand for wage labour. While the population continues to increase at the present rate, the need for the expansion of wage labour, either on the land or in industries, will persist.

Finally, economic expansion and industrialization is not by itself a panacea for the pressures and problems besetting this tiny island Kingdom; techniques will need to be changed, social privileges equalised, and human resources marshalled and developed, especially in the fields of education and vocational training. Education for white collar jobs carries greater prestige, but efficient production of export crops may be more lucrative for the individual.

At present, compulsory primary schooling ends at standard IV, a class reached by many children at the age of ten. Intermediate and secondary schooling is not compulsory, so if primary school pupils do not gain a place in one of the few secondary schools they repeat the last year in the primary school once or even twice. Because of this an enormous percentage

88: Thaman OU9 Tonga OU9

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[For information on government programs of agricultural development, see Category 654.]

241 The present Tongan farmers have a wealth of empirical
433 knowledge about their environment and traditional crops and cropping practices. Unfortunately, as suggested by Schultz, new forms of capital are needed to provide for the
241 future. Foreign degrees in agricultural science, agri-
433 cultural machinery, pesticides and fertilizers, breeding
178 stock and planting material from overseas, and technical
177 and financial aid are already beginning to bring about
242 changes in the traditional agricultural system.

Nature of Study

128 It is the primary aim of this dissertation to look at the Tongan agricultural system as it existed in 1971-1972. Particular emphasis will be placed on plant species, plant associations, and selected agricultural practices.
121 There are two major reasons for conducting an investigation of this nature. The first is the general concern which geographers have for man's relationship with and effect on the earth. A much more immediate reason, however, is that because steadily increasing population pressure is forcing agricultural systems to change dramatically, better understanding of traditional agricultural systems can help effect change with minimum cultural disruption and shock.

Studies which have dealt with some aspects of traditional Pacific Island agricultural systems are numerous. Most of these fall into four general categories:
1) general descriptions of the agricultural landscape and

134 "Lapaha clays" which are predominant in Eastern Tongatapu and in small areas near Nuku'alofa; and "Vaini clays" which cover most of the uplands from Kolovai in the west to Fua'amotu in the central part of the eastern upland. Both groups have free draining top soil layers, ranging from 12 to 18 inches (30 to 46 centimeters) in depth, with well developed nut-like structures, and containing numerous small stone fragments. The Lapaha top soils range in color from black to dark brown and the Vaini top soils are generally dark brown.

134 The differences, however, are so minor that Tongans 242 rarely differentiate between the two, referring to both as kelefatu. Nevertheless, most farmers do have considerable empirical knowledge of areas of variable soil fertility resulting from the nature of the parent material, micro-topographic differences, the nature of the fallow 134 vegetation, and the nature of cropping practices. Gibbs (1967: 220) points out that, as a result of over intensive cultivation, "the colloidal oxides are liable to be made inert (fixed) by drying and that some of the stones in the surface soil appear to represent unsoluble accumulations of these oxides. These stony accumulations appear to be more numerous in areas of frequent clean cultivation."

The upland soils generally range from slightly alkaline to slightly acidic in reaction. The top soil is generally more acidic owing to the accumulation of organic

134 Although the differences between the Nuku'alofa and
242 Sopu soils seem to be obvious, Tongans generally refer to them both as tou'one. Some waterlogged hydromorphic soils
134 are distinguished as 'umea or kelekele'umea. Lowland soils or tou'one range from highly alkaline to neutral in reaction and are low in available nitrogen, phosphorus, and potassium and high in available calcium and magnesium. Citrus and some other crops show an iron deficiency in some low-lying areas (Nakagawa, 1971) and most nutrients
[242] are easily depleted by heavy cropping. Nevertheless, Tongans find these soils suitable for most crops except yams, and particularly suitable for sweet potatoes.

[241] In short, the soils of Tongatapu, although somewhat
[182] deficient in certain nutrients, provide an excellent basis for traditional Tongan agricultural practices. Furthermore, owing to the well-drained nature of most of the soils and the lack of relief, few if any cases of soils erosion are encountered on the island.

241 **Primary Vegetation**

A major feature of traditional shifting agricultural systems is the felling of trees and other vegetation and burning of the dried remains. When yields begin to decline, a new section of forests or bush is cleared.
241 Theoretically, if given a sufficiently long fallow or
137 intercropping period, the primary vegetation should re-
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137 311 The two major concentrations are found just west of the airport at Fua'amotu on the property leased by Tupou College and on the Royal Estate at Kauvai bordering the central lagoon. There are numerous other smaller stands throughout the island, some too small to be mapped. The 137 311 764 242 presence of these isolated stands can in some cases be attributed to the traditional practice of preserving small groves for family burial grounds or to the belief, held by many Tongan farmers, that if all of the native forest species and their shade are removed, the soil will cease to be fertile.

137 The remnants of this tropical lowland forest have a characteristically closed canopy composed of trees reaching heights of over 60 feet, a limited understory, and a number of epiphytes and lianas. The dominant tree species are Rhus taitensis, Alphitonia ziziphoides, Elaeocarpus tonganus, Ellattostachys falcata, Aleurites moluccana, Ervatamia orientalis, Dysoxylum forsteri, Syzygium clusiaefoluim, Grewia crenata, Tarenna sambucina, Xylosma orbiculatum, Vavaea amicorum, Santalum yasi, and Ficus spp. Outer margins and more open areas are dominated by secondary species such as Hibiscus tiliaceus, Glochidion spp., Macaranga harveyana, Morinda citrifolia, and Bischofia javanica.

The understory in the dense inner forest, where present, consists of Micromelum minutum, Jasminum

245 is found on almost all bush allotments, planted either in systematic rows or in a random fashion, in varying numbers on most town allotments, as well as growing naturally along the coast. Numerous kinds of coconuts are known to Tongans, the most common varieties being niu kafa, niu mea, niu matakula, niu ui, niu'utongau, niu mea'alava, niu leka and niu ta'okave. Very little scientific selection of high yielding varieties is practiced, the planting material in most cases consisting of suitable fallen nuts. With the establishment of the Coconut Replanting Scheme, however, new varieties from Sri Lanka were introduced and nurseries were established to improve selection of local planting material. Coconut palms are planted throughout the year, take from seven to ten years to come into bearing, and bear fruit through out the year.

Watermelon - meleni (Citrullus vulgaris). The watermelon, which is native to the Kalahari Desert of Southwest Africa (Herklots, 1972: 314), was possibly first introduced into Tonga by Captain Cook on his second voyage (Beaglehole, 1969: 262). It is Tonga's third most important export crop, is a major item at the local market, and is grown on bush allotments throughout Tongatapu on a commercial basis. There are two kinds of watermelon commonly grown, the "Ice Cream" and "Market Wonder," both of which are referred to as meleni by Tongans. Although the "Ice Cream" is sweeter, the "Market Wonder" ships

244 [439] better and is favored for export (Johansson, c. 1956: 3). Although melons are planted throughout the year, the best planting time is from May to August during the drier part of the year. At this time, there is a lower incidence of fungal diseases and other pests and the melons tend to be sweeter. Watermelons take about three to four months to mature with the largest harvests occurring from August [438] through December. Planting material consists of seeds purchased either through stores in Nuku'alofa or from the Produce Board.

245 Pineapple - fainā (Ananas comosus). The pineapple is of tropical American origin (Prevost and Pitkanen, 1970:58), and was an early European introduction, probably by Cook on [438] his second voyage in 1773 (Beaglehole, 1969: 262). It is [439] grown in large patches throughout Tongatapu for export and local sale, as well as being intercropped with other crops on both bush and town allotments. The two most common varieties are the "Rough" and the "Ripley Queen", known locally as fainā Tonga (Tongan pineapple) and the piu respectively. The Ripley Queen is favored for export owing [439] to it's larger size (Johansson, c. 1956: 3). The optimum planting season for pineapple seems to be from September through December; the plants begin to bear in about 14 months and are most abundant from September through January. [242] Some farmers have been producing crops throughout the year by treating the plants with a hormone. Planting material

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Turmeric - ango (Curcuma longa). Turmeric, supposedly of Indian origin and probably Pre-European introduction (Yuncker, 1959: 86) is cultivated and found growing naturally throughout Tongatapu. The rhizome is used in making a yellow dye (enga) and in the preparation of medicines.

[386] [278]

Arrowroot - misimisi koka'anga (Maranta arundinacea). The common arrowroot, a native of tropical America and the West Indies, was probably an early European introduction (Herklots, 1972: 356). It is found only occasionally in a cultivated state on town allotments and is used as a substitute for Tacca leontopetaloides and Manihot esculenta in the preparation of paste for tapa making.

[287]

249 242

Hyacinth bean - piini Tonga (Dolichos lablab). Native to the Old World Tropics and probably introduced (Stone 1970: 333; Parham, 1972: 112), the hyacinth bean is found occasionally on bush allotments planted on fallow land to restore soil fertility. The use of it in this capacity is encouraged by the Agricultural Department. In times of food shortage, the seeds are also eaten.

[262]

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Kava'aukava or kava Fisi (Derris elliptica). Native to Indomalaysia and possibly a recent introduction from Fiji, kava Fisi is occasionally found in both a planted and a natural state on bush and town allotments. The roots are used to stupify fish (Parham 1972: 111).

[226]

245 439 Japan and provided the stimulus for the great increase in production. During 1967 and 1968 bananas surpassed copra as the number one export and many Tongan farmers planted large portions of their bush allotments with bananas in order to share in the considerable profits that were being made.

245 137 Unfortunately, in 1967 black-leaf-streak fungal disease (Mycosphaerella fijiensis) and bunchy-top virus led to a drastic reduction of banana production in Vava'u and Ha'apai, especially during the warmer months (Government of [242] Tonga, 1968a:4-5). By 1968, despite regular spraying programs conducted by the Department of Agriculture, bunchy top and black-leaf-streak broke out during the summer and [136] early fall on Tongatapu. Also a factor in the incipient decline in 1968 was a root nematode (Radopholus similis) [439] (Government of Tonga, 1969a:6). The black-leaf-streak was worse in 1969 and banana exports from Tongatapu dropped by 245 approximately 60 percent. Production again decreased in 1970 and 1971 and many farmers have become disenchanted and given up banana cultivation.

245 654 In an attempt to combat declining banana production, the Tonga Produce Board, in co-operation with the Department [457] of Agriculture and subsidized by Fruit Distributors Ltd.of [439] New Zealand (the firm which buys all of Tonga's present banana exports), approved a Banana Rehabilitation Scheme in 1971. This required growers to plant one acre or more of at

[TEXT CONTINUED ON PAGE 167]

245
439 Table 26 continued.

	Tongatapu	Tonga	Tonga
	No. of Cases* (1000)	No. of Cases* (1000)	Value ($T1000)
1969	191	209	680
1970	121	143	464
1971	81	118	358

*The size and dimension of banana cases have changed a number of times between 1951 and 1971.

Source: Tonga Produce Board Records.

245
654 least 500 plants with no intercropping, to control weeds to a reasonable standard, to practice desuckering and leaf-trimming, and to destroy bunchy-top affected plants. The
[242] Agriculture Department's responsibilities were to apply
[136] fertilizer at a rate of two pounds per plant per annum, to spray to control black-leaf-streak; to supply two percent DDT powder for control of the banana scab moth (Nacoleia octasema), and to keep a register of approved growers (Government of Tonga, 1972b:5-6). Despite these strong measures, in late 1971 most farmers were still reluctant to plant bananas and very few bush allotments had healthy banana plantations.

241 439 [441] [655] on which the bulk of their exports are grown.

Most export produce is, however, shipped through the Produce Board, and a great percentage of this is grown on the individual bush allotments. Vanilla, which is an important export crop in Vava'u, is now being grown in the Ha'apai group and on Tongatapu. Experimental export of cantaloupe (rock melon) and strawberries have also been made, and schemes to export onions, garlic, and corn to Fiji are under consideration. In 1971, to encourage the production of other export crops, a laboratory was established and manned by a trained plant pathologist to study diseases and insects that are prevalent in the Kingdom.

242 439

443 Domestic Agricultural Income

The market place in Nuku'alofa, which began as a collection of periodic street vendors after World War II, evolved into a modern open-air facility known as Talamahu Market, which officially opened in October 1970. The market takes up four acres (1.6 hectares), contains 47 lock-up stalls, 80 tables, considerable floor space for additional sellers, toilets, taxi stands, and a bus depot.

443 438 The market deals primarily in native subsistence produce, mainly staple crops, vegetables, and fresh fruit. It also handles a limited amount of native fiber goods, tapa cloth, native medicine, beverages, spices, and more recently handicrafts. Some prepared food, firewood, shellfish, live pigs, and chickens are also sold outside the walls of the

241 For commuting between the bush and town allotments and
481 transporting agricultural produce, the commonest modes of
494 transportation are walking, riding horses, horsecarts
493 (saliote), bicycles, and buses. Of a sample of 140 house-
492 holds, only 9 percent owned a motor vehicle whereas 26
percent owned bicycles; 28 percent owned horsecarts (saliote)
494 and 48 percent owned horses. The percentage of households
369 owning bicycles and motor vehicles and those riding buses
to their bush allotments was higher for Nuku'alofa than the
rural areas, whereas understandably the reverse was true of
241 those owning horses and horsecarts. Farmers desiring to
494 transport considerable volumes of crops, firewood, or other
427 material often rent trucks or horsecarts. In maintaining
241 the fertility of the soil, Tongan farmers have considerable
242 empirical knowledge and understand the necessity of crop
rotation and a sufficient fallow period. They realize that
stands of large trees or certain shrubs and herbs, such as
Lantana camara, Leucaena leucocephala, Paspalum conjugatum,
and Phaseolus semierectus, indicate better soil than species
like Panicum maximum, Cyperus rotundus, or Sida rhombifolia.
They also realize that the length of the fallow period has
been declining and that the soils are presently more
impoverished than in the past. The primary means that most
Tongans use to improve soil fertility are fallowing and
[654] burning dead plant material. The government encourages the
use of commercial fertilizers, and out of 137 sample house-

241 holds, 41 percent have used commercial fertilizers at one
242 time or another on their bush or town allotments. In almost
654 all cases, however, it was used for commercial purposes and not on traditional vegetable or tree crops. Of those 56 households using fertilizer, 43 percent received it from the Agricultural Department; 39 percent from the Tonga Produce Board; 16 percent from the Coconut Replanting
241 Scheme; and only 2 percent from other sources. There are
242 also very few instances of Tongans mulching their crops or planting green manure crops. Only the hyacinth bean (Dolichos lablab) is purposefully planted for green manure, and this practice is infrequent.

Similarly, the use of insecticides and fungicides is generally limited to commercial crops. Of the 133 households interviewed, only 23 percent used insecticides, and of these 31 households, 48 percent used them primarily for bananas; 48 percent for watermelons; and 3 percent for garden vegetables. The same pattern exists for the use of fungicides, with only 26 percent of the 133 sample households using fungicides. Very few if any people use herbicides to eliminate noxious weeds.

241 Irrigation is another technological problem hindering diversification of Tongan agriculture. Whereas subsistence crops, such as yams, taro, giant taro, bananas, and manioc, depend largely on available rainfall, commercial crops such as watermelons and garden vegetables need periodic watering.

241 312 Because there are no surface streams on Tongatapu, the required water must come from either wells or storage tanks. Of 134 sample households, only 33 percent water for cropping on their bush allotments. Of the 134 households, 13 percent had wells; 1 percent had cement catchment system; and 20 percent transported water from their town allotment or from other bush allotments. There are motorized pump irrigation systems on large plantations, lands of the missionary societies, and on a few bush allotments that were not included in the sample survey.

On town allotments irrigation is more prevalent. Out of 150 sample households, there was a greater percentage of households with dependable water sources: 29 percent with wells, 15 percent with cement tanks, 9 percent with corrugated iron tanks, 9 percent with private piped-in water, and [365] 70 percent with access to a public water system. In the area of Nuku'alofa where there is a public water system, there is a corresponding increase in the intensity and 241 231 656 diversity of cropping and planting or ornamentals. This however, is due partially to a law prohibiting unpenned or untethered pigs and other animals in town.

242 654 241 241 242 The Department of Agriculture's Experimental Farm at Vaini and a number of missionary societies have experimented with a wide variety of new crops in an attempt to improve subsistence and commercial agricultural production. These experimental crops, as well as many past introductions such

241 as sorghum, rice, soybeans, and macadamia nuts, are very
242 rarely found on bush or town allotments. With the exception of seeds for watermelons and garden vegetables, which are generally purchased at the large trading stores in Nuku'alofa, most planting material for crops grown on the allotments is obtained by Tongans either from their own stock or from friends.

231 The Department of Agriculture has, since 1968, begun
654 Pig, Poultry and Cattle Subsidy Schemes designed to upgrade
[241] Tongan livestock production. The Pig Subsidy Scheme, which was initiated in 1968, provided three weaner pigs, bred from New Zealand stock, to Tongan farmers who were willing to construct suitable pig sties with cement floors and a water supply, and to plant approved food crops--such as manioc, corn, and sweet potatoes. The Department also supplied the farmer with sufficient protein supplement until pigs reached slaughtering weight. The pigs were then to be marketed, after which the farmer would be credited with money to buy his own breeding stock and protein supplement to start his own pig farm (Government of Tonga, 1969a:15).

235 The Poultry Subsidy Scheme, initiated in 1971, provides
654 one-half of the initial poultry stock to those farmers who construct poultry houses according to Agriculture Department
[439] specifications. The poultry distributed to farmers is reared from New Zealand stock imported since 1970. Additional aims of the Poultry Subsidy Scheme include a

241 bush.

241 Of all commercial crops, coconut palms seem to receive
241 the least care and on 42 of the 101 sample allotments
245 there was evidence of wasted nuts rotting on the ground. There was also considerable evidence of rat damage to coconut palms; 8 allotments had numerous fallen nuts which had been gnawed by rats and another 23 allotments had some evidence of rat damage.

241 There were 7 cases where at least one-quarter acre of
242 hyacinth bean (Dolichos lablab) had been planted as a green manure crop and another 13 cases where it was present in smaller concentrations. This is one of the green manure crops introduced by the Department of Agriculture.

241 As for preparation of land prior to cropping, there were 82 cases where burning was evident and 43 cases where
[654] plowing was evident. The government encourages plowing and discourages burning because it injures coconut palms and often causes wildfires, especially in Vahe Loto, the Central District.

241 Improvements which were found on the 101 allotments
361 included 13 permanent residences and 13 temporary thatched huts. Where permanent homes were present, allotments were usually better maintained and had more cultivated trees and plants, such as garden vegetables, which require constant care. The temporary dwellings are generally used while guarding crops from theft or when a farmer or his family stay overnight at the bush allotment.

241 137 [242] of food, medicines, firewood, fodder, fish poisons, and other valuable products (Table E).[A] Some such as Cyperus rotundus, Commelina spp., and Psidium guajava constitute noxious weeds which have become a current focus of government control programs.

A number of allotments also had uncultivable areas under "natural" vegetation. These allotments were usually found on the coast and included areas of littoral forest on the low-lying leeward northern coast. Although of limited agricultural potential, they are sources of many useful products and constitute gene pools of many species rapidly disappearing from most bush allotments.

241 178 With respect to agricultural practices and improvements on bush allotments, the technology used by Tongan farmers seems to have changed only slightly in the past hundred years. With the exception of the increased cultivation of manioc, American taro, sweet potatoes, and recently introduced banana clones, traditional crops and tree species are still the dominant features of the agricultural landscape. Cultivation techniques have also changed very little from what was described in the mid-seventeenth century (West, 1865:130-139; Maude, 1965:162). 241 [412] Bush fallow is still the primary means of restoring soil structure and fertility; the most widely used tools are machetes and steel bladed hoes and fire for clearing the [242] vegetation. There is some deliberate planting of Dolichos

[A] [See Category 137, pp. 377-431--Analyst.]

241 lablab to improve fallow vegetation as well as an increas-
242 ing use of inorganic fertilizers. In most cases, however,
[654] fertilizers were supplied by the Coconut Replanting Scheme or the Agricultural Department for use with coconuts, bananas, watermelons, or export vegetables, rarely for subsistence crops. The practices of mulching or use of animal manure were seldom employed.

241 The use of plows and disc harrows for the clearing
407 and preparation of land was common, and approximately one-half of the allotments have been plowed at one time or another. In most cases, however, plowing was done under
241 [654] the auspices of the Coconut Replanting Scheme. Commercial
[244] crops such as peanuts and watermelons were often grown on plowed land, but plowing for staple root crop production was uncommon.

[244] Most staple crops were well weeded, except for manioc and taro which seemed to compete successfully with weeds.
241 Commercial crops also seemed reasonably well cared for,
245 except in the case of pineapples which were often overrun by secondary growth and some banana plantations where proper desuckering was not practiced and diseased plants were poorly weeded.

241 Tree crops, however, received very little attention,
245 and coconut palms, both mature and replanted, were often
136 found overrun by secondary vegetation, burned around the bases during clearing, or left prey to rat, rhinoceros

241
245
[36]
[23] beetle, and coconut stick insect predation, with little or no attempt at control. The damage caused by these pests, plus damage to young palms by fire and escaped or grazing livestock, was considerable.

241 Pest control, in general, was rare except for commercial crops. Here the purchase of pesticides, fungicides,
241 and herbicides was usually borne or at least subsized by
654 the Agricultural Department or the Commodity Boards. In the case of control of black-leaf-streak in bananas, misting oil was actually applied by Department of Agriculture personnel.

241 Formal irrigation systems were rarely if ever found
312 on bush allotments, and simple wells were found on only about one-tenth of all bush allotments. The use of water for irrigating short term crops such as vegetables and watermelons generally required carrying water in drums from the town allotments or from nearby wells.

241 The effect of the "Green Revolution" seemed to be
242 almost non-existent. Although the Government Experimental Farm has successfully grown a wide range of new plants such as sorghum, soybeans, rice, and macadamia nuts, very few have been integrated into traditional cropping sequences. In some cases, garden vegetables such as tomatoes, capsicum and bulb onions were planted, but these often required additional non-traditional and expensive inputs such as fertilizers, insecticides, fungicides, and irrigation.

241 And finally, livestock husbandry was much more widespread on town allotments than 369 on bush allotments. 231

241 Current Trends and Developmental Paths

Based on the nature of the Tongan agricultural system 178 in 1971-72, there seemed to be some definite trends within the system and developmental paths that it might follow, all of which should lead to more intensive use of the land and increased productivity. Some of these trends or possible developmental paths include:

241 Decrease in Leasehold Land and Expansion of Bush and Town Allotments

178 As leases expire, many are not being renewed and the 423 land is in some cases being subdivided into bush and town [427] allotments. More recently, bush allotments are often four acres in size and town allotments less than one-quarter 241 acre. The existence of these smaller allotments should 178 lead to more intensive cultivation, as was the case with most of the sampled undersized allotments.

Increase in Scientific Farming Methods

[654] As a result of government encouragement and subsidies, [242] there seems to be a definite increase in plowing and disc [312] harrowing; the use of pesticides, fungicides, herbicides, and fertilizers; the introduction of new crop varieties; the use of fencing; and dependence on some form of irrigation.

244 178 [438] potato (Ipomoea batatas). These crops, all of which were infrequently cultivated before the turn of the century, now have become the most common items sold at Talamahu Market, and manioc and American taro were the two most widely cultivated crops in terms of acreage.

241 178 Increased Cash Cropping

There will probably be a continued expansion of cash cropping to supply both overseas markets and the expanding [242] [654] urban population on Tongatapu. The major focus of government extension work is the expansion of commercial cultivation of bananas, coconuts, and a variety of other established crops such as watermelon, pineapple, garden vegetables, and root crops; and experimental crops such as [435] macadamia nuts, onions, strawberries, and garlic. The rising prices of products at Talamahu market is also a major incentive for an increase in commercial production of both traditional and recently introduced crops.

434 439 178 000 Increased Cultivation of Crops Used for Handicrafts

With the rapid expansion of tourism throughout the Pacific, there is a great demand for the high quality Tongan handicrafts both in Tonga and overseas. Consequently, there could be a considerable expansion in the cultivation of plants such as paper mulberry (Broussonetia papyrifera), pandanus (Pandanus spp.), Job's tears (Coix lachryma-jobi), and bamboo (Bambusa sp.).

244 /155 cont./
[137]

410. Th. West, Ten Years..../cited in English/ p. 139.

as a newly introduced plant, and at that time it was obviously of little importance. The conditions for growing of manioc, however, seem to be quite favorable in the Archipelago with respect to climate and soil, so that the plant, the cultivation of which is, moreover, very simple, has since then become widespread. Particularly in the [134] Ha'apai group where, as a result of over-population, the soil has been [262] used to excess and is in part exhausted, it has taken on greater importance in the diet of the natives, although they still give preference if possible to their old crops--for reasons of taste and 241 tradition. For the rest, the gifts of seeds left on the islands over centuries by sailors, researchers and missionaries have had relatively little success. Maize which grows well in Tonga is planted in small amounts, and watermelons and pumpkins have not taken on great importance; pineapple is little planted and then mostly to be sold, and there is still very slight interest in onions, cabbbage, tomatoes and peanuts.

242 In the entire Archipelago--even in the Ha'apai group with its over-population--the Tongans have retained their old system of crop rotation with its accompanying "fallow season": after clearing the bush land they plant yams; the second year kape and/or taro (or sweet potatos or manioc) are planted; beginning with the third year they let the land in question rest (for about three years). (411)

411. Sometimes they also plant manioc the third year and only then let the land lie fallow for several years.

A period of fallow is, however, observed only if yams are part of the crop rotations. For example, they plant taro, manioc or bananas continuously or alternate them, so that some land has not had a rest period 241 for several decades. They are not familiar with fertilization, except

/155 cont./

241 for the accidental green manure from decayed parasites on banana trunks and the ashes from burning the slashed and dried wild plants when the land is cleared. The apparently recent but /156/ obvious exhaustion
241 242 (134) of the soil on several Ha'apai islands, (412)

412. It is impossible for many land-poor Tongans always to observe the necessary period of fallow.

leads to the fact that here the less exacting, "new" manioc plant is in places planted more abundantly than the demanding yam; on Nomuka, for example, yam cultivation ceased altogether for a time until it was discovered in 1943 that the plant flourished once again. It was on this particular island that the Forsters (413)

413. G. Forster, loc. cit. V. p. 150.

saw an abundance of harvested yams.

242 The planting together of various crops on the same land (for example, yams with bananas, sweet potatoes with kape and bananas) is a procedure already practiced in ancient Tonga, (414)

414. See, for example, J. Cook, Beschreibung... loc. cit. VI. p. 284.

a[illegible] is apparently based on early experiences of biological suitability.
241 245 178 656 The planting of coconut palms has, however, as a result of copra production by the natives, become greater than in the past; the government prescribed division of the api'uta into half for coconut palms and half for crops has on some islands shifted to such an extent that some plantations are covered up to seven-eighths with coconut palms in between which bananas, kape, taro, manioc, etc. flourish.

412 241 177 The tool the Tongans use for cultivation has changed as a result of European influences, insofar as the old wooden digging stick (huo) that was flattened at the end and was not much wider than two to four inches (415)

/158 cont./

000 kape (less often taro or yams). With these tools they usually work
241 standing. The former, apparently customary, squatting method of work
412 (418)
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418. See, for example, J. Wilson, A missionary voyage.../cited in English/ p. 245.

407 is used only by a few very old men. Plows as well as other agri-
177 cultural machines and tractors are used by Tongans under the guidance
242 of whites only on the state experimental farms on Tongatapu and on the property of Crown Prince Tungi on this island.

121 The following survey may give an insight into present-day agri-
241 culture and show the changes that have taken place.

244 'ufi - Yams (Dioscorea alata L.)
262 Even in ancient Tonga yams were one of the most important food
178 plants (if not the most important crop). (419)

419. See J. Cook, Beschreibung...loc. cit. VI. pp. 163, 237, 283/284; W. Ellis, An authentic narrative...I. p. 89.

[563] White employees in the Tongan government have so far discovered 80
[137] varieties of yams in the Archipelago; more than 20 different names are familiar to the average Tongan. Yams are still the favorite tubers on all the islands, though their total cultivation has decreased in Tonga in comparison with the past (see above); in the Ha'apai group yams are today planted to a lesser extent, whereas their cultivation on the larger islands of the Archipelago (for example, Tongatapu) is still quite extensive and in some places probably corresponds to that of the past.

244 Planting time--with certain shifts as a result of the long north-
221 south extension of the Archipelago--extends from June to the first days of August and from the third week of August up to October-November. As
244 a rule, a yam crop is planted only on land that has rested; suitable
242

/158 cont./

244 [242] [412] ground is recognized by the type and size of the wild plants growing there. The weeds are cut down with the thrusting iron (huo lafa-lafa) (see above) and the machete (hele pelu) (see above). After a week or so the dried weeds are burned and the land is cleared--for example, [462] swept. Women also take part in this work, whereas all the rest of the cultivation activity is the business of the men. The holes for plant- [412] ing are dug with the Tongan "digging-stick spade" (huo spade) (see [804] above) to a depth of 0.5 of a meter to one meter and approximately one-fourth of a meter in diameter; the distance from one plant hole to the next (approximately 1.80 to 2 meters) is measured by the eye or with a measuring tape (European tape or coconut cord [kafe]) and a stick or stalk, so that rows are formed and the entire layout of the "yam garden" looks like a chess board. The /159/ plant holes are filled loosely with earth so that the tubers can grow deep into the ground. On the soft earth one piece of yam root is lain four to six weeks in an earth-covered pit approximately one-half meter deep, for sprouting.) Over the plant pieces the natives heap the earth with their hands to form small hills. After a week or two the young plant grows out of the hill. They cut twigs and lay them under (between) the plants, so that the latter can "climb"; (420)

> 420. A special type of yam ('ufi lei) is also allowed to climb up dead tree trunks, posts, cords and wires.

today this saves the natives the work of having to turn over the ground in the field every day to protect the plants from scorching [412] in the hot earth. The weeds which soon appear are removed--generally every week or two--with the huo lafa-lafa. The harvest takes place after eight to twelve months (depending on the variety). After the yams have shown that they are ripe by the leaves turning brown and drying up, the tubers are taken out of the ground. First the natives

101: Clark K-4,5 (1974) 1978 OU9 Tonga OU9

134 provide for crop needs.[1] The practice of burning-over land, which 241 follows clearing, represents a significant factor to soil composi- 134 tion. This constant burning severely limits the amount of humus in the soil and acts to reduce the amount of available nitrogen 241 (Hougland 1974). A further negative effect of burning is evident in 245 cash crop production. Improper timing of the burning process often results in damage to coconut palms, thereby reducing the number of nuts produced. Several 'apis were observed where burning had totally destroyed the immature nuts of producing palms.

241 Following burning, very little ordering of the land is done. Occasionally, a farmer may rent a small tractor to plow his land, but usually the cost is prohibitive or the procedure is considered unnecessary. The planting of crops in Tonga involves little more than digging a hole in the soil, planting, and leaving the crop largely untended until maturity. Few farmers effectively weed more than the immediate planting site, and planting often follows no pattern of rows or other orderly arrangement.

[242] Tongans evaluate land fertility by the presence of such wild vegetation as weeds and grasses, plus previous experience with the [425] given land. However, land shortages in the more densely populated areas often limit the choice of planting sites, and even in cases where land is borrowed, usually only the poorer land is lent, and thus secured for planting.

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[124] [1]This information was obtained from an examination of Tongan soil, in conjunction with interviews conducted at the Tongan Government Experimental Farm.

101: Clark K-4,5 (1974) 1978 OU9 Tonga OU9

241 Two features of the bush fallow system of particular interest are crop interplanting and crop succession. Interplanting was found to be practiced by over 90 percent of all landowning farmers engaged in cultivation. When questioned as to the reasons for this practice, the most frequent response concerned a desire for increased production on limited land. However, several additional advantages were observed. Interplanting reduces farm labor requirements, in terms of weeding, to only minor maintenance activities. Interplanting also retards soil erosion, such as on the steep slopes of Vava'u and the more sandy soils of Ha'apai. In addition, it is believed that the soil nutrient requirements of interplanted crops are frequently complimentary, although this was not tested.

242 241

The cycle of crop succession in Tonga is primarily based upon a farmer's knowledge of his land's condition and fertility, plus the fertility requirements of individual crops. Yams are planted first because they require a loose soil, such as is found following the clearing process, and a higher soil fertility.

241 242 244

Taro and cassava, the most frequently planted second and third crops, are less demanding on soil fertility. Cassava is particularly notable in this respect. Thus, in the more densely settled portions of Tongatapu and Ha'apai, where the fallowing periods are much shorter and, consequently, soil fertility is lower, cassava is more frequently cultivated.

241 [244 [245

Tuber cultivation, such as for yam, taro and cassava, represents the principal farming activity in the Kingdom's food production. However, several supplementary crops are noteworthy, the

245 retards the growth and development of the plant, and terminates fruit production.

[136] Banana scab moth, most destructive during its larval stage, may cause damage ranging from simple fruit discoloration to total [242] destruction (Plate 4, p. 74). ^A DDT, which is frequently used to combat scab moth, has been ineffective in annihilating the pest.

241 The combined effect of these three diseases have reduced 245 internationally marketable banana production by nearly 1.5 million [433] dollars, representing approximately 30 percent of total agricultural [439] export production since 1967. Farmers are increasingly hesitant to initiate large scale banana production, unless guaranteed assistance in combating disease and plant destruction.

245 Survey interviews also attributed decreasing banana produc- 505 tion to inadequate shipping facilities. Frequently, harvested bananas are placed on a dock to await the arrival of transport 245 vessels destined for overseas markets. During this time, the fruit 439 becomes over-ripe, falling below export quality. As a consequence, [435] fruit originally priced up to $1.90 per case may be sold for as little as 40 cents. Because of this potential low cash return, 245 many interviewed farmers stated that large scale banana production was an unwise economic risk.

244 Commercial production of melons, especially watermelons, is also hindered by the inadequate scheduling of transport facilities to [505] overseas markets. Melons are also produced for Tongan markets, but [438] frequently earn only low prices, even when out of season.

[435] A [Because of poor quality of original reproductions, plates have not been marked for a Category-- Analyst.]

241 Survey information covering the 1973-74 cropping year indica-
242 ted only scattered and infrequent use of any type of pest control by Tongan farmers. Only 25 percent of those farmers surveyed used
[654] spray or dust pesticide of some type. Most often this was DDT, supplied by the Tongan Department of Agriculture. Application of this was usually concerned with combating the scab moth for banana production. The expansion of cash cropping, whether in plantation or bush fallow production, is significantly limited by this lack of pest control.

Food cropping for home use, mainly tuber production, does not notably suffer from pest destruction, with soil fertility depletion being the major cause of reduced yields. Fertilizer is beyond
[435] the economic means of the typical Tongan farmer. The cost of basic
[654] fertilizer, such as urea, increased from $120 to $220 per ton in 1973-74 (Hougland 1974). Of the total survey sample of farmers cultivating land, only two percent used any kind of fertilizer, and it usually was supplied by the Tongan Agricultural Department. More readily available sources of fertilizer, such as green manuring or the spreading of animal manure, are untraditional in Tongan farming and, therefore, unfamiliar and unused. The bush fallow system remains the major technique employed in Tonga to increase soil fertility.

241 In the bush fallow system, a given plot undergoes a cropping cycle of up to seven years. Declining yields during this period make continued cultivation unprofitable, and the garden area is shifted
241 to another portion of the 'api. Nitrogen depletion appears to be
134 the major cause for crop yield reduction. Maude (1965) reported no

101: Clark K-4,5 (1974) 1978 OU9 Tonga OU9

density in excess of 600 persons per square mile, in some regions. Surveys determining fallow periods evidenced a marked decrease in fallow time in Ha'apai and densely settled portions of Tongatapu, and a subsequent lengthening of the cropping cycle. In many cases, cropping is continuous, considering the frequent practice of sparsely planting fallow acreage with tubers.

The use of fertilizers necessary in offsetting the nutrient depleting effect of intensive cropping is not financially feasible nor understood by the typical Tongan farmer. The issue of maintaining soil fertility is of critical concern to the few agricultural and soil technicians in Tonga. However, owing to prohibitive cost, scarcity, and lack of knowledge, it is expected that most Tongan farmers will continue to rely upon the fallow system for replenishing soil nutrients.

The problems of soil fertility and land availability in Tonga have resulted in the increased cultivation and household reliance upon taro and cassava as major food staples.[1] Cassava represents the best example of the variation in food cropping brought about by increasing pressure upon the land. In a status ranking of tubers grown in Tonga, cassava is found at or near the bottom. However, even though the least desirable, cassava is the

[1]Both tubers were introduced into Tonga in the nineteenth century, although a variety of taro was cultivated in Tonga prior to that period. The introduced taro varieties are more tolerant of dry, upland conditions, as opposed to the marsh requirements of the earlier species. Today most taro is cultivated without a marsh environment. Cassava is an introduced food crop. Of the cultivated tubers, cassava is lowest in status and its increasing cultivation is due to necessity, rather than any growth in popularity.

101: Clark K-4,5 (1974) 1978 OU9 Tonga OU9

000 the continued movement of people into the urban areas, principally Nuku'alofa.

3. A third recommendation for immediate implementation calls for quality inspection of food imports. The quality of most fresh meat and canned beef products is indicative of this necessity. As food products assume a greater proportion of total Tongan imports, the continued lack of efficient quality inspection is seen as detrimental to the health and nutrition well-being of urban Tongans.

In addition to recommendations for immediate action, it is advisable that long-term planning and implementation of the following be undertaken.

1. Agricultural education of extension services for use in all rural settlements is advisable. Such an undertaking is feasible considering the existence of the government farm on Tongatapu and the agricultural training facility on 'Eua. [242] [368]

2. Basic family hygiene and nutritional education is also advisable. The formulation and instruction of fundamental home economics or family ecology could easily be incorporated in the nation's secondary schools. In view of the fact that continuing education is viewed as a status in Tongan society and literacy is almost universal, it is reasonable to suggest such an introduction in the Tongan educational system would reach a large segment of the population.

3. A reorientation of the subject areas of emphasis in the educational system might also be a long-term goal. Development of technical skills, including construction and fundamental